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Note on the Phenomenon known as "Shadow Bands."

By Dr. R. Copeland.

I had read accounts of the "Shadow Bands" sometimes seen during solar eclipses, in the *Astronomische Nachrichten*, Nos. 1921 and 1922, and elsewhere, but had not the slightest idea that any kindred phenomenon could occur at sunset or sunrise until December 18, 1879, when an appearance of the same kind was most conspicuously visible on the inner wall of the great dome at Dunecht. The bands, or rather lines, were, generally speaking, about $\frac{1}{4}$ inch broad, almost exactly horizontal, and some $2\frac{1}{2}$ inches apart. They were produced by the last rays of the Sun then setting behind the smooth horizontal ridge of the Hill of Fare, five miles distant. The lines ascended at the rate of a foot and a half in a second, and had a distinct quivering motion. The lines were seen by Herr Lohse (the assistant astronomer) and by the writer. An account of them was published in a recent No. of *Nature*.

The bands having been once seen were naturally looked for on subsequent occasions. Their occurrence proved to be very uncertain and variable. There are very fine sunsets which do not give a trace of them even on the whitest surface most completely screened from any but the direct light of the Sun. At other times the lines are short, crooked and disconnected, *descending* as well as ascending, forming and disappearing within a few seconds.

On January 13, 1880, when the Sun was setting behind the slope of Greymore (one of the summits of the Hill of Fare) the profile of which is inclined about 20° to the horizon, the northern end being the higher, Herr Lohse saw the dark lines running *downwards* for about 20 seconds. The apparently regular intervals were about half an inch broad, while the thickness of the lines was, roughly, $\frac{1}{8}$ inch. The motion was about one foot in four or five seconds. The lines were not horizontal but parallel to the slope behind which the Sun was disappearing. The lines became visible on a sheet of white paper in a room with one closed plate-glass window when about two-thirds of the Sun's disk had disappeared. Prior to this for a short time there was an irregular ripple-like mixture of light and shade, which also had a decided downward motion.

On February 3, 1880, the writer saw the lines much broken and disconnected, some ascending, a greater number descending, while a few formed and hovered on the screen, disappearing in a few seconds.

One appearance may be mentioned, as it gives what seems to be a clue to the origin of the lines. Most people have noticed the small crescent-shaped images of the partially eclipsed Sun formed by its rays passing through foliage or other imperfect obstruction. In the same way when the disk of the setting Sun is reduced to a mere line and its light falls through the branches of a leafless tree the partial images so formed are reduced to straight lines

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1880MNRAS..40..330N

separated by straight dark bands parallel to the apparent horizon. This occurs whatever may be the average direction of the branches.

In the case of lines formed by the crest of a distant hill (or the Moon's limb) it is assumed that irregularities in the densities of the various strata of the intervening air form the requisite obstructions, and as these irregularities vary from instant to instant, so do the lines move or change. When the source of light subtends a very small angle we have scintillation. From this point of view the dark lines are a phenomenon of scintillation projected on a screen. This hypothesis readily explains the coloured fringes of the eclipse shadow bands seen by some observers.

As seen from the neighbourhood of the Observatory at Dunecht, the Sun sets behind one or other part of the treeless ridge of the Hill of Fare for about nine weeks before and after the winter solstice. For the rest of the year the Sun disappears or reappears behind a wooded horizon far less favourable to the production of a regular phenomenon of the character described. The Sun being now beyond the limits mentioned, these notes are laid before the Society in the hope that some member who resides in a favourable locality may be on the look-out for the bands. It is at least favourable, if not essential, to their visibility that the screen on which they are formed should be protected from side light, and that the observer should be very close to the screen.

A couple of white screens making a known angle with each other and with the horizon, exposed in a room with an open window but with partially closed shutters, would probably be a good arrangement.

On comparing the above with the account of the eclipse shadow bands at p. 47, *Mem. Royal Astronomical Society*, vol. xliv., it occurs to the writer that the apparent rotation of the bands about a distant centre there described was most probably an effect of perspective, just as furrows transverse to a line of railway appear to rotate before the eyes of a traveller. In future eclipses it may be well to see if the bands rotate about *two* opposite centres, or vanishing points.

Dunecht Observatory,
1880, *March* 6.

Note on the Photographic Diameter of the Moon. By E. Neison, Esq.

In his Note in the *Monthly Notices* for January 1880 (page 167) Prof. Pritchard adduces complete evidence of the accord between the measures made by himself and by the two assistants of the Oxford Observatory. It is with great satisfaction that I learn that the lunar photographs taken at Oxford will permit of such sharp and accordant measures being made. The difference $0''\cdot56$ between the separate results of Mr. Jenkins and Mr. Plummer is insignificant.

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